Totnes Passivhaus Bed and Breakfast Certified Passivhaus

Link attached family home with bed and breakfast in Dartington, Totnes, Devon, UK – view of front (east) façade.

Certified Passive House
Passive House Institute

Project ID: 2305

Architect:	Janet Cotterell, CTT Sustainable Architecture, Passivhaus Homes
Passivhaus Designer/client:	Adam Dadeby, Passivhaus Homes
Builder:	Jonathan Williams, Williams & Partners, Passivhaus Homes
Project blog:	http://passivhausrefurb.blogspot.co.uk/

This “single family house” was retrofitted and enlarged as a private home but has also been used as a small bed and breakfast for people who are curious to experience a Passivhaus. Completed in August 2011 and Certified the following month, it was the third retrofit to be Certified as a Passivhaus. Certification pre-dated the introduction of the EnerPHit and the newer Passivhaus Plus and Passivhaus Premium classifications/standards. The existing structure is made of dense concrete blocks and is typical of the “cavity wall” constructions used in the majority of the UK’s residential housing since the 1930s. The new additions are timber-frame – I-joists with blown-in insulation and woodfibre.

Exterior wall U-value:	0.095W/(m^{2}K)	**Roof U-value:**	0.10W/(m^{2}K)
Party wall U-value:	0.13W/(m^{2}K)	**PHPP predicted specific annual heat demand:**	**13 kWh/(m^{2}a)**
Floor U-value (retrofit):	0.20W/(m^{2}K)	**PHPP predicted Primary energy:**	68 kWh/(m^{2}a)
Floor U-value (new build):	0.075W/(m^{2}K)	**Airtightness Certification test result:**	0.20 a.c.h.
	MVHR system (unit and ducting) heat-recovery efficiency:		90%

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View from north east

View onto living roof over extension

View of stairwell

View of kitchen

2 Short description of project

The project was the third Passivhaus retrofit project to achieve Passivhaus Certification in the UK, in September 2011. It was the first Certified Passivhaus retrofit to address the particular problems of a typical 20th Century UK masonry constructed building, with twin leaf-cavity walls – very common in the UK. The existing building is of dense concrete block construction and the addition built from an optimised timber frame. The existing house was built in 1971 but was badly in need of extensive repair and had a large backlog of maintenance. The house forms part of a modernist estate so the design had to address the perceived architectural 'group value' of the estate. Overhanging eaves or prominent shading devices were not acceptable to the planning authority and the roof form, orientation and finish result from the context. A combination of high performance materials was used in the retrofit (as dictated by the retrofit's performance needs – externally on the walls and on the ground floor concrete slab) and a 'natural materials' led design for the new-build element. The original architect of the estate, of which the Totnes Passivhaus forms a part, was Leonard Manasseh and is referenced in the Pevsner architectural guide and as such the estate is seen as architecturally sensitive/significant.

Views of original building before the Passivhaus retrofit and extension

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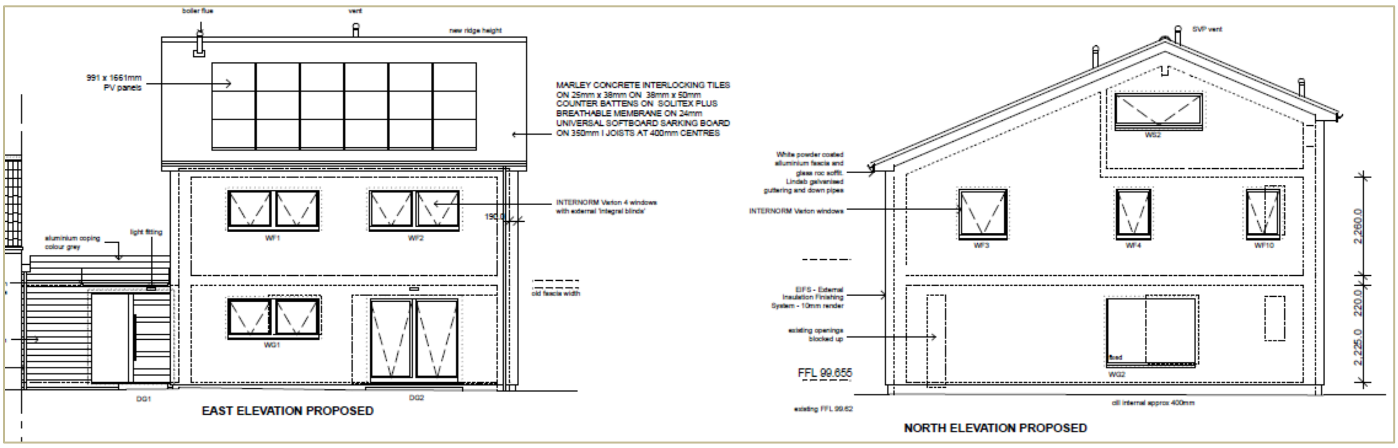
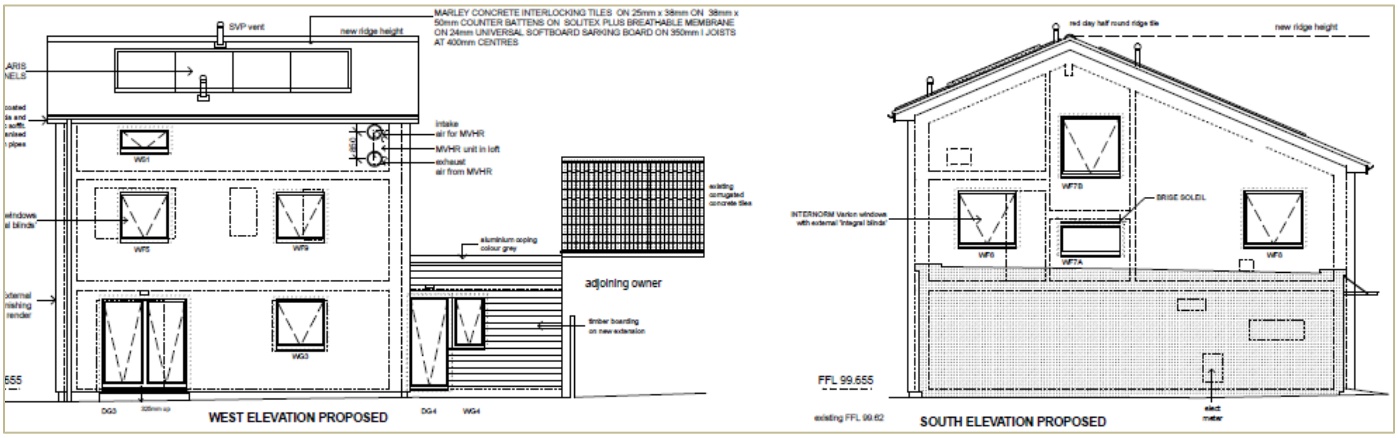
Views of the estate of which this building forms a part

Project timetable

April 2009 – May 2009	Project initiation/definition, pre-planning enquiries
May – June 2009	Architect selection
September 2009	Completion of property purchase
October 2009 – April 2010	Detailed design and PHPP modelling
February 2010	Contractor selection
April 2010	Submission of planning application
July 2010	Re-design following change of heart by planning authority
26 October 2010	Planning permission granted
8 November 2010	Construction commences
5 April 2011	First air-tightness test: result 0.4 ach
21 July 2011	Certification air-tightness test: result 0.2 ach
19 August 2011	Move back into house
September 2011	Passivhaus Certification

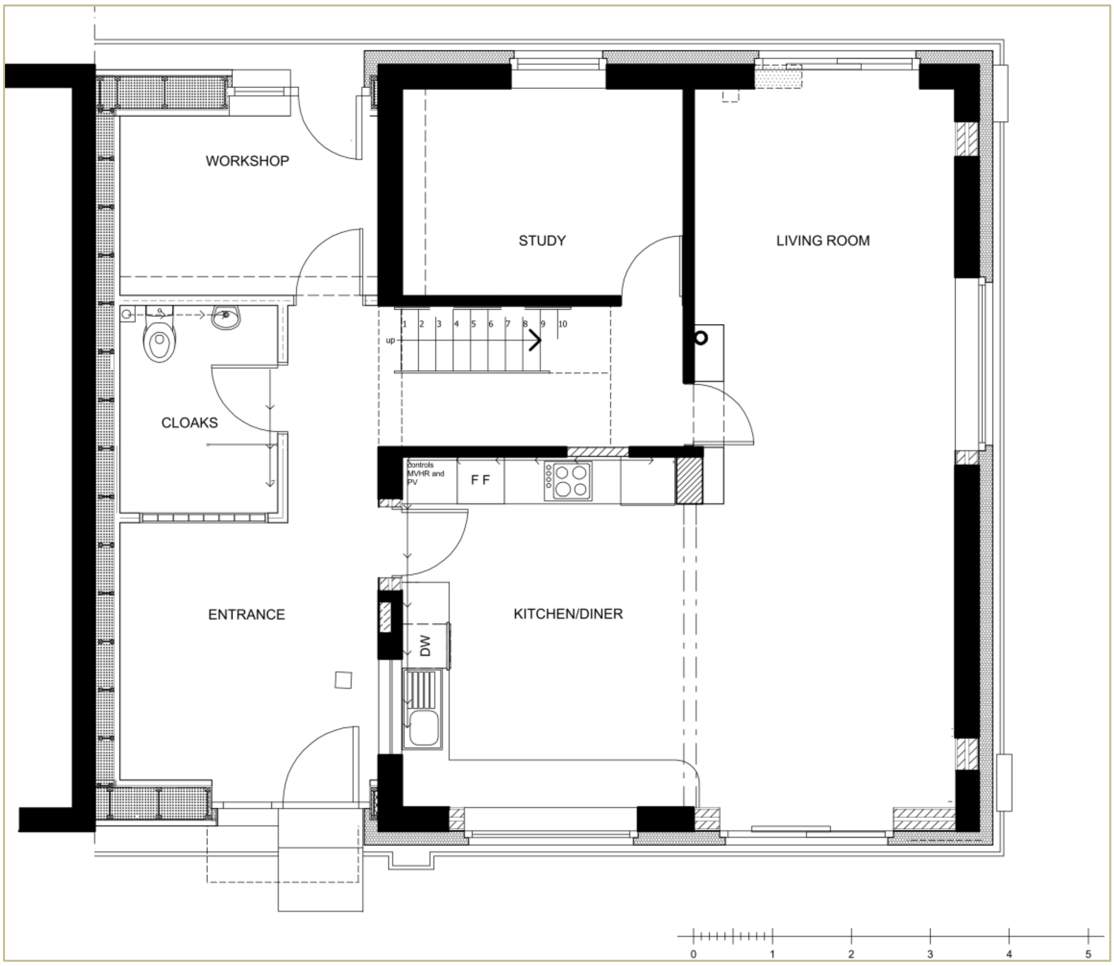
Elevations





6 Plans (new ground floor, first floor and second floor)

Ground floor



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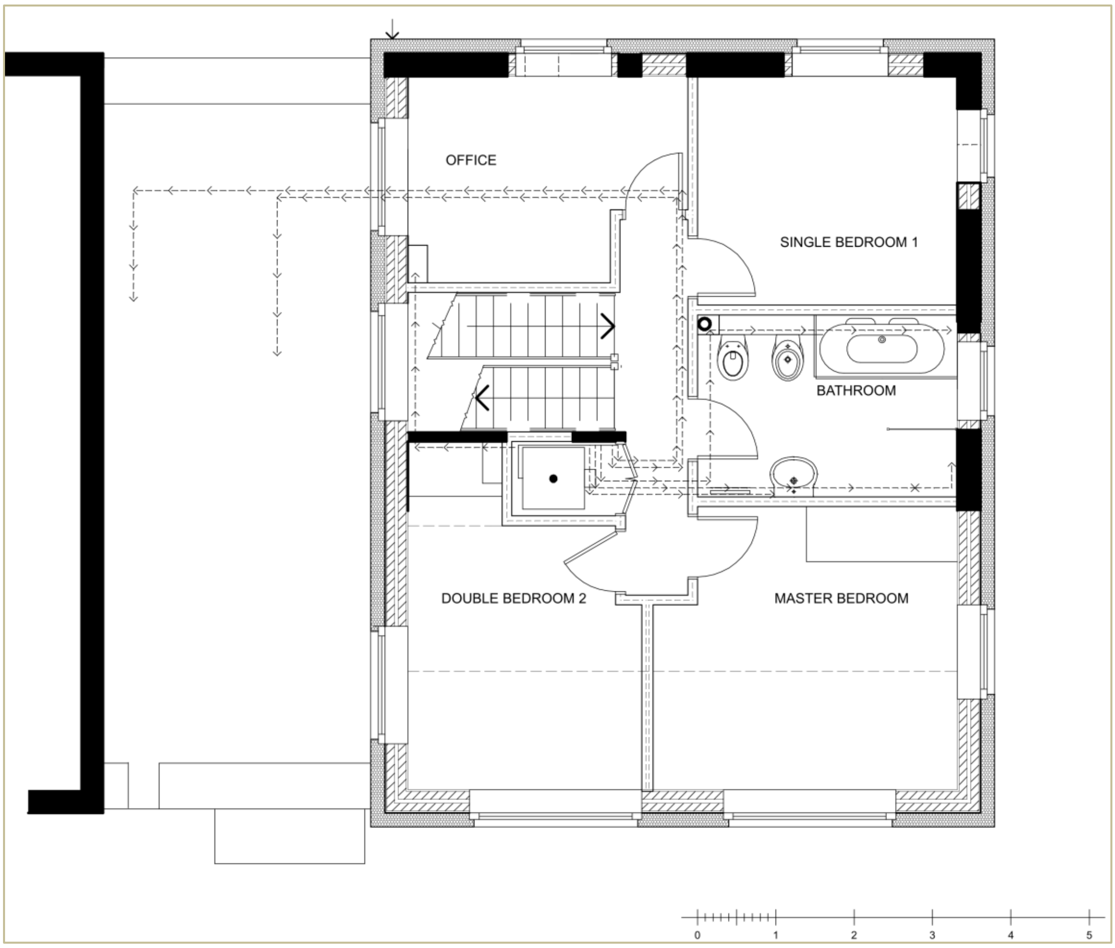
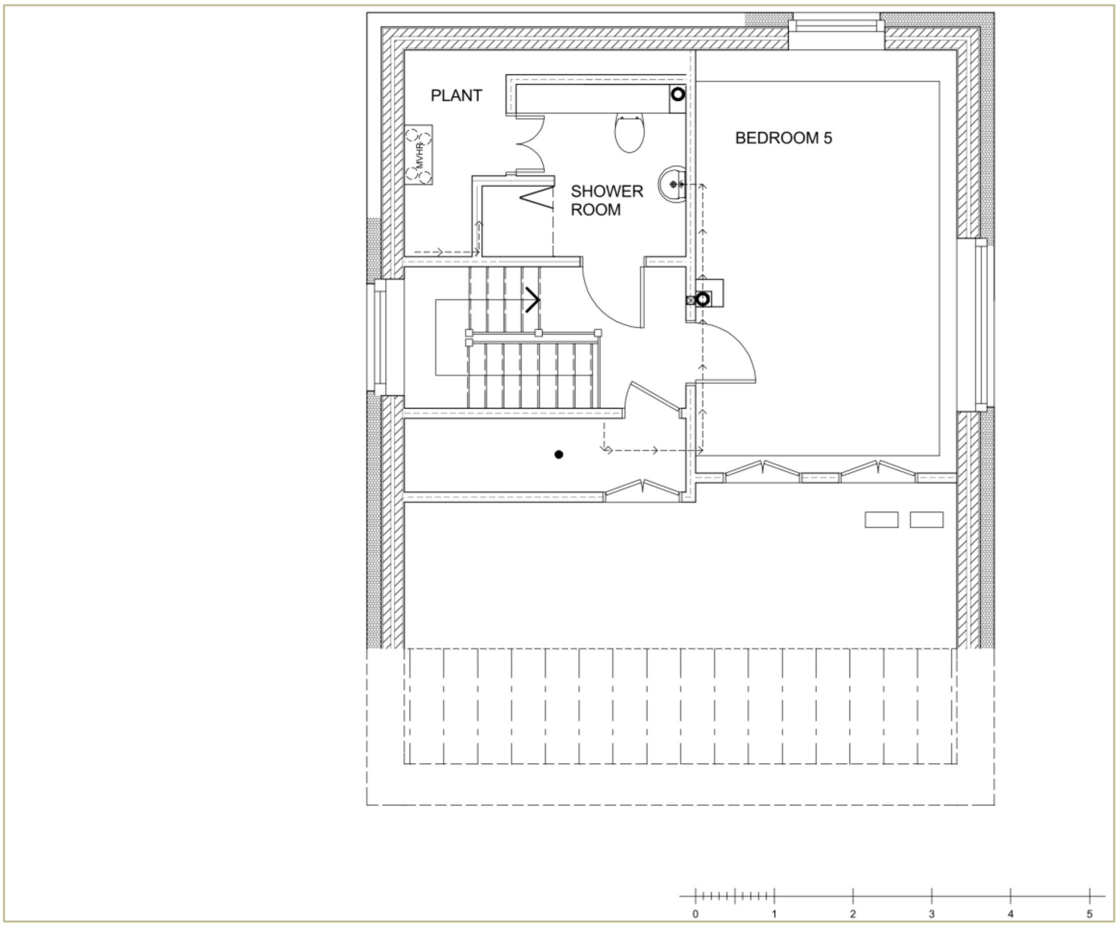
First floor



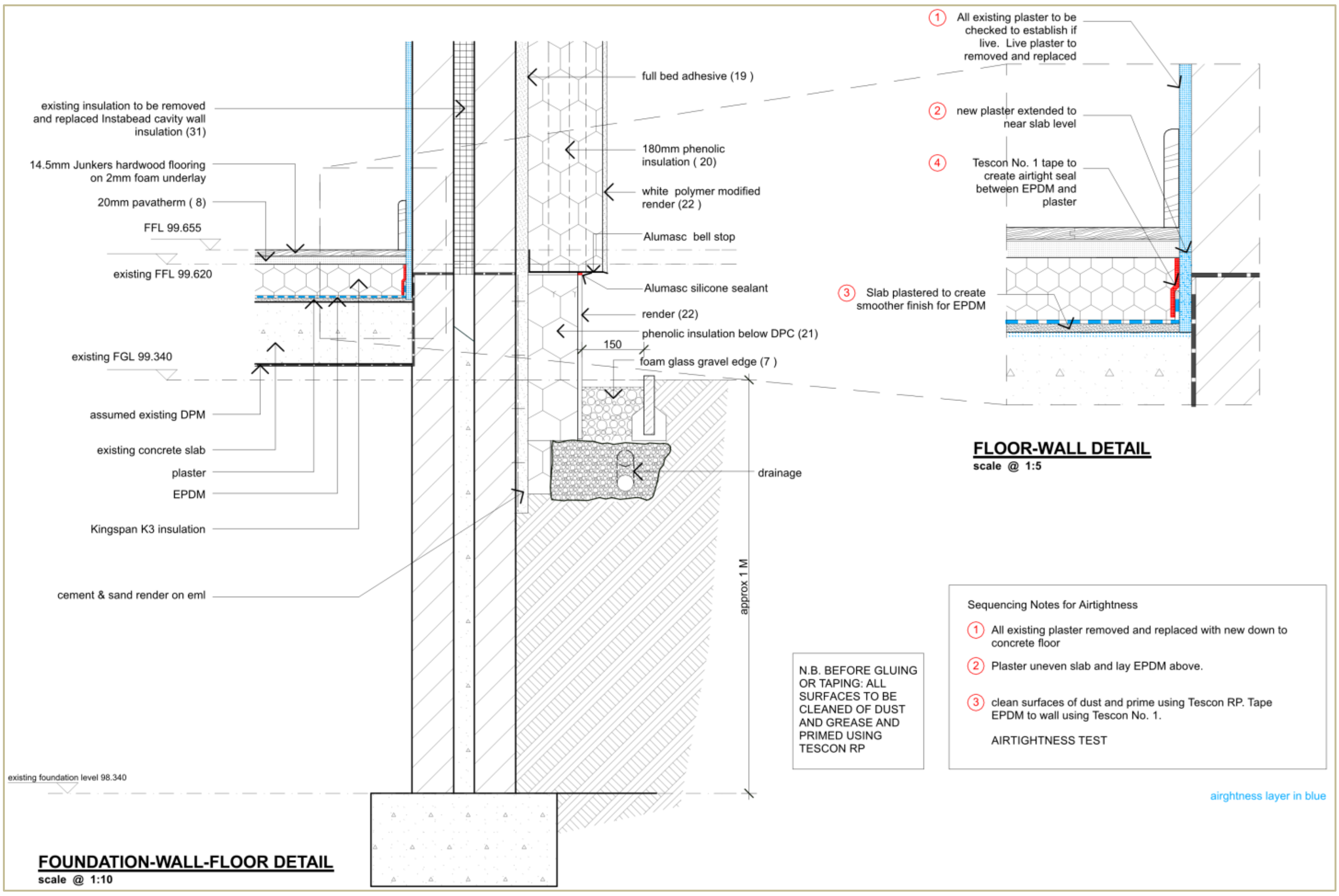
Second floor



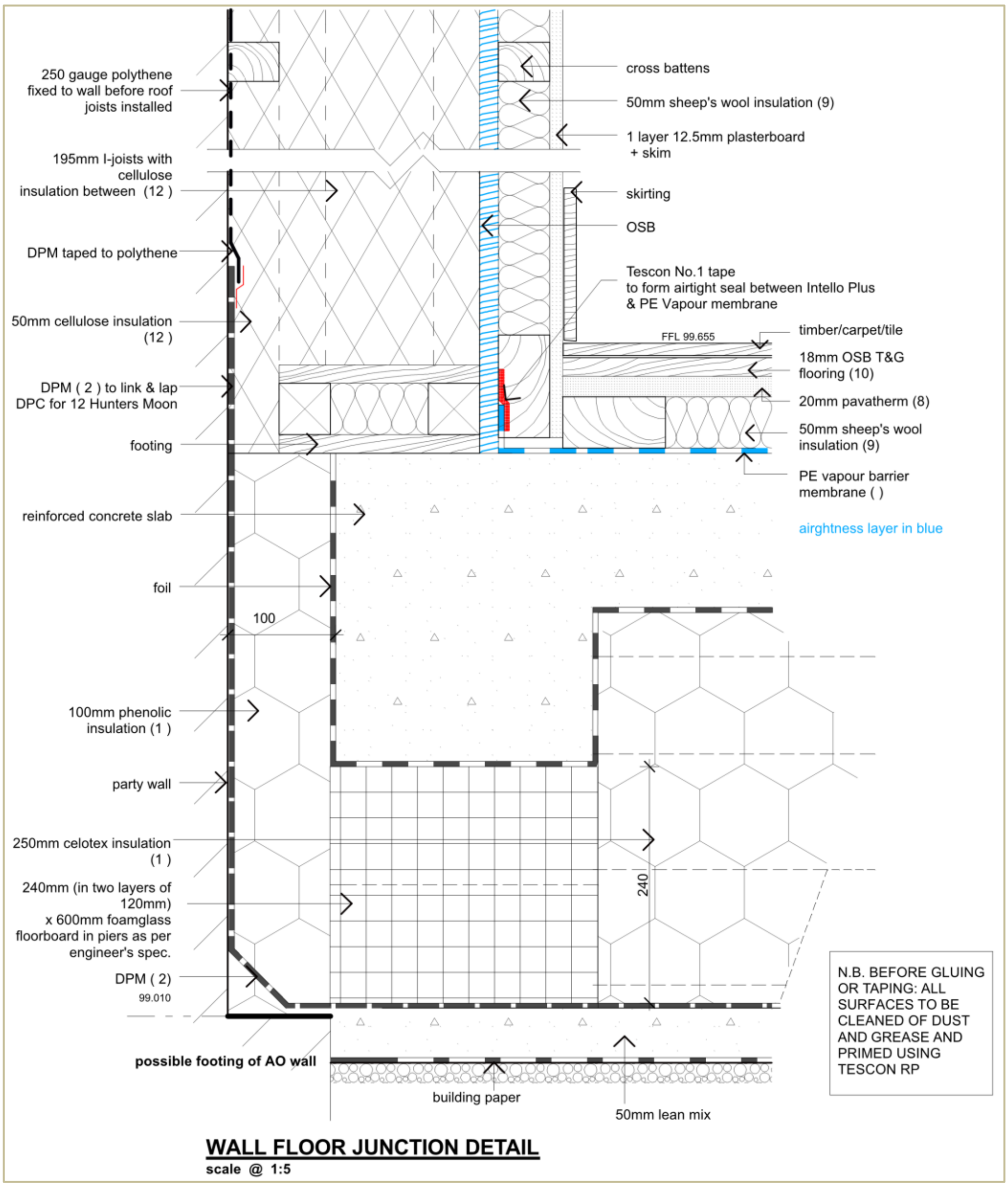
7, 8 & 9 Description of floor construction, exterior walls and roof (retrofit and new build elements)

Retrofit floor slab and exterior walls – the existing slab was retained and 100mm of vertical space was gained for insulation by removing the screed and all existing floor elements. An airtightness layer was placed on the slab connecting with renewed internal wall plaster. On top of this is: 80mm of Kingspan Kooltherm phenolic foam insulation; 20mm of woodfibre insulation; a slim floating floor. On the exterior perimeter, 120mm external insulation runs 350mm below the finished ground level to reduce the perimeter thermal bridge. This is shown in the drawing below.

The original cavity walls were also retained. The existing blown-in cavity insulation was replaced with InstaBead Graphite K32. 180mm of phenolic foam exterior wall insulation (Kingspan Kooltherm) was attached with insulated wall fixings and completed with an acrylic render.



New floor slab and exterior walls (extension) – this was designed to be thermal bridge free and uses load-bearing Foamglas Perinsul HL in piers to insulate under the "toe" of the concrete slab to provide continuity of insulation and provide sufficient compressive strength to support the building's load. The foam insulation is Xthratherm PUR rigid foam. See drawing and photo below:



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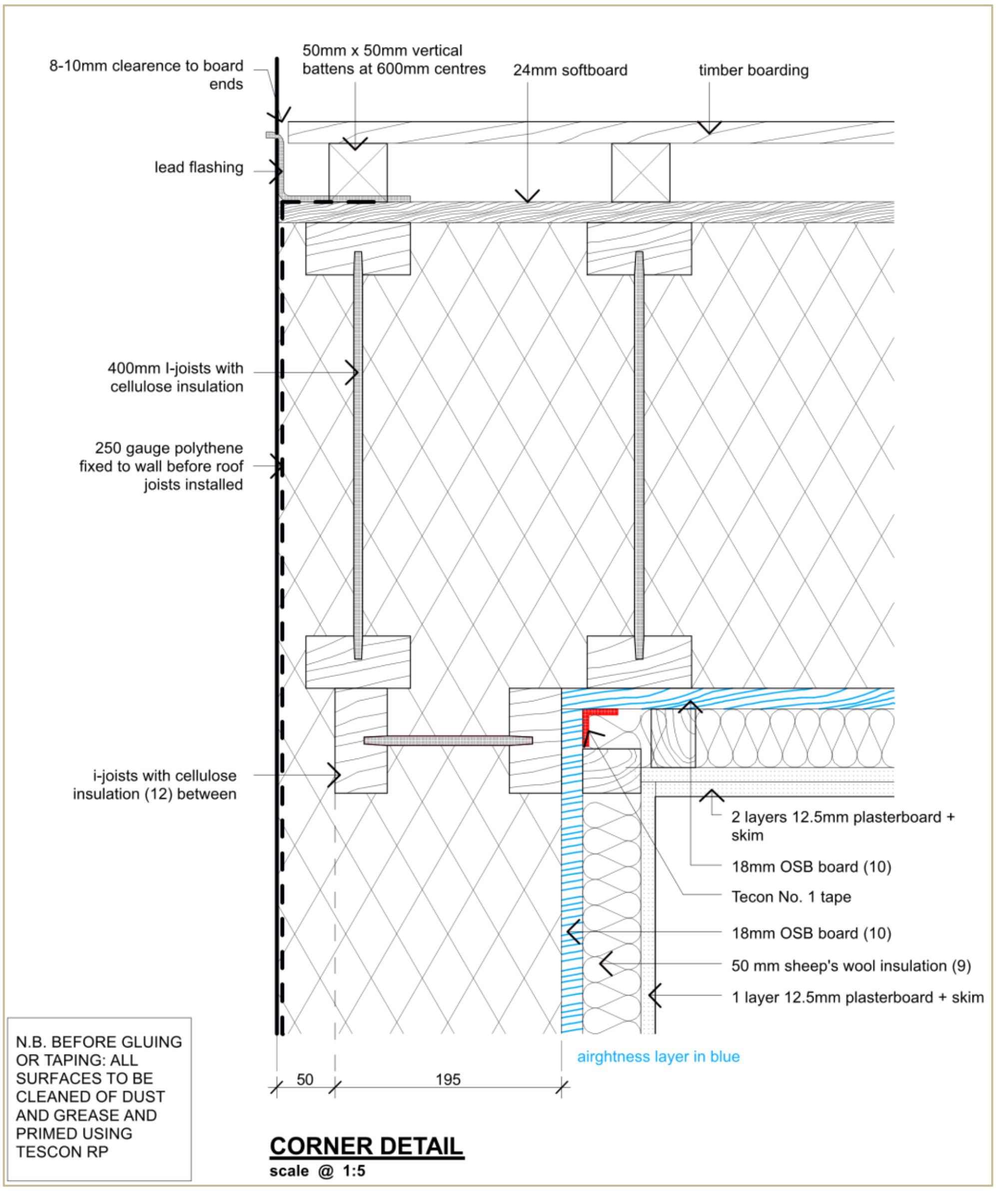
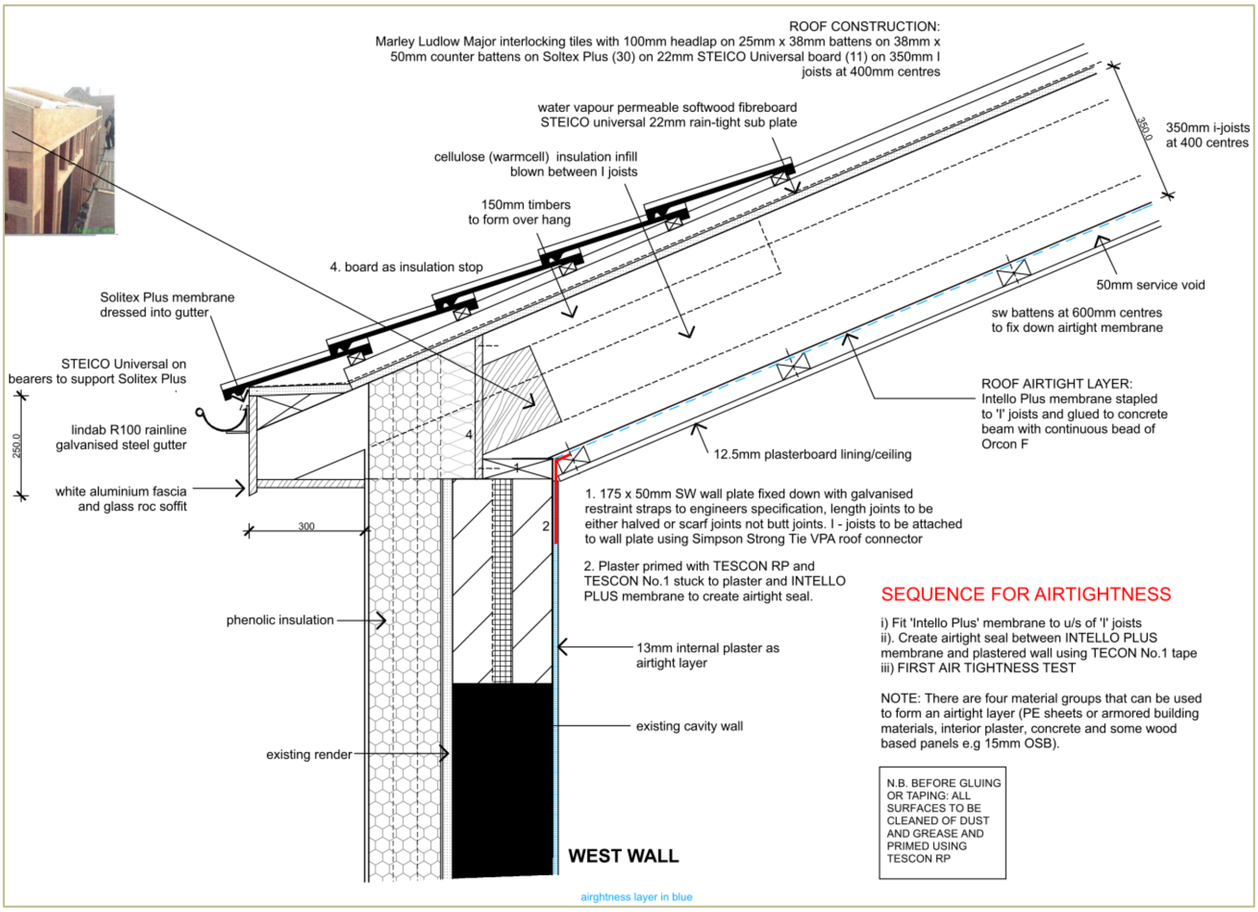
The external walls in the extension are built from Steico timber I-joists in a layout optimised to minimise the "timber-fraction". The corner junctions have also been detailed similarly. The drawing and photo below show the junction between the west wall and the south wall, which is slimmer and abuts the neighbouring property.



The original mono-pitch roof in the existing building was replaced by an aesthetically more traditional twin-pitch roof. This provided additional accommodation and the resulting more compact shape of the building dramatically improved the form factor (ratio of usable floor area to heat-loss area). This was one of the key changes that allowed the design to meet the Passivhaus standard. Where needed, the existing dense concrete block cavity walls were extended up or repaired using Thermalite blocks, as shown in the photo below:

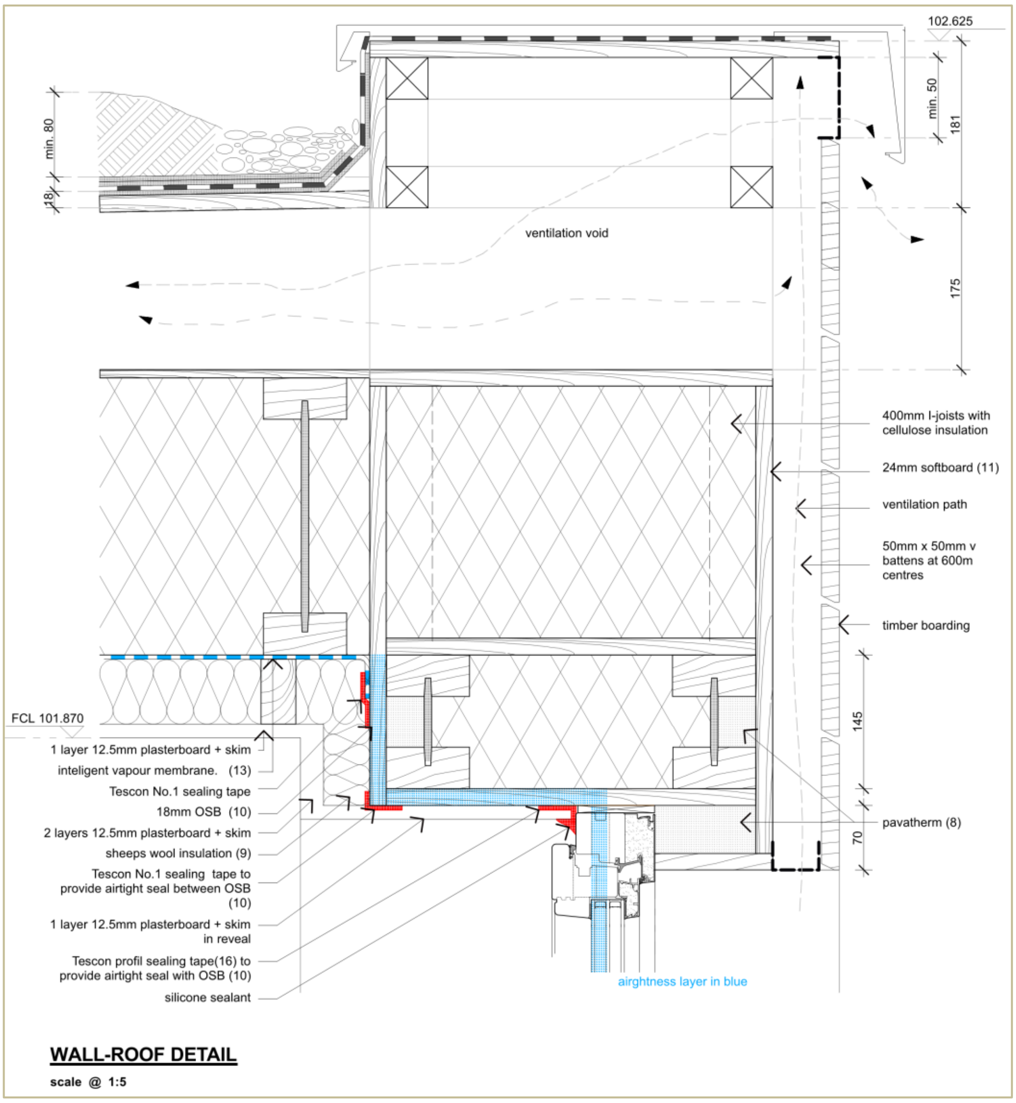
The roof is made from timber I-joists



The semi-completed roof-wall junction, as it was before the external wall insulation and blown-in cellulose insulation were installed, is shown below. Sheepswool insulation was installed in the spaces that were inaccessible to the blown-in insulation and the external wall insulation.

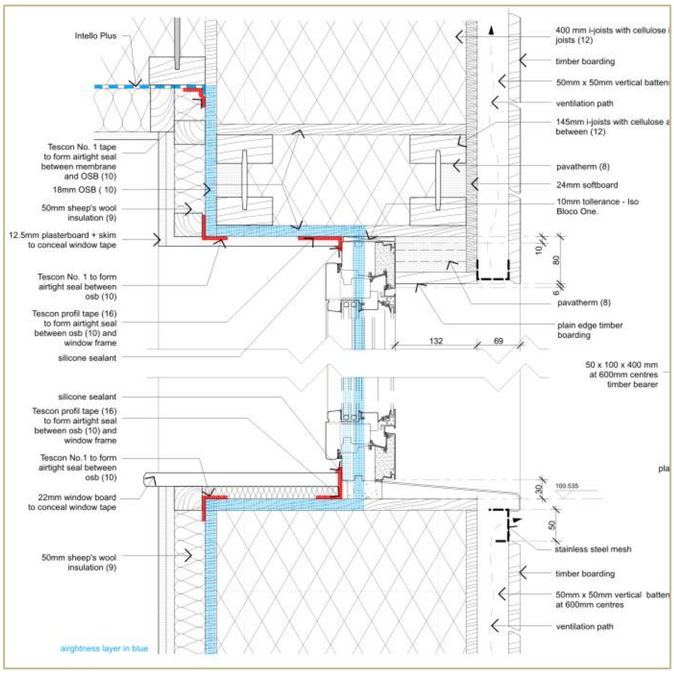

K5 EWB

The extension roof is a flat, living roof supported on timber I-joists with a 100mm ventilated void.

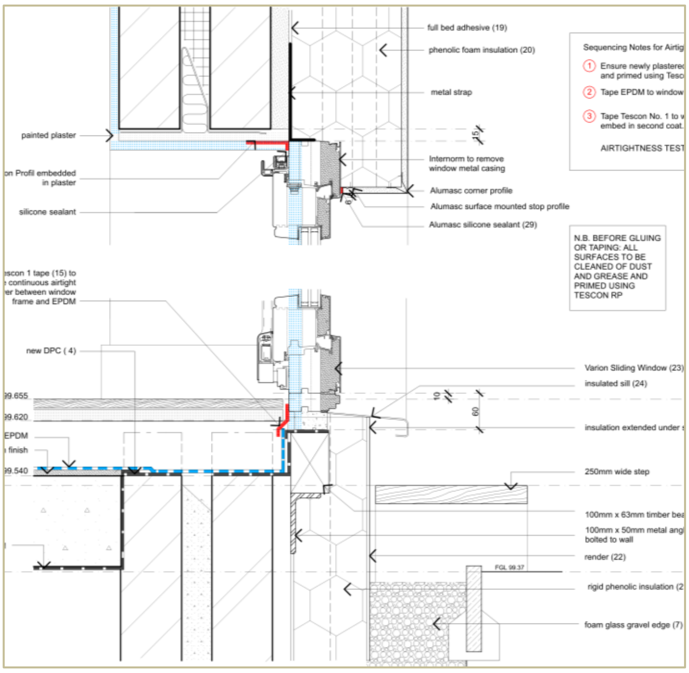


10 Windows

New build extension window installation detail



Retrofit masonry window installation detail



Retrofit window installation

Retrofit external insulation – frame over-insulation

Window specifications – windows were manufactured by Internorm. Models “Varion/Varion 4” (with integral blinds)
Window frame –timber (larch) with aluminium cladding – Uf 0.94W/m²K
Glazing – Argon filled, double e-coated, triple glazed – Ug between 0.60 and 0.90 W/m²K; g-value between 50% and 60%
Airtightness – double/triple all-round EPDM seal
Entrance door – Internorm Selection; patio doors – tilt-and-slide

11 Airtightness Testing – testing volume 442m³ - envelope area 424m²

The testing at first fix (photo below) produced a result of 0.4 a.c.h. The test allowed the build team to correct and improve on the initial result. The final Certification test result was 0.2 a.c.h.

Test results (certification test)

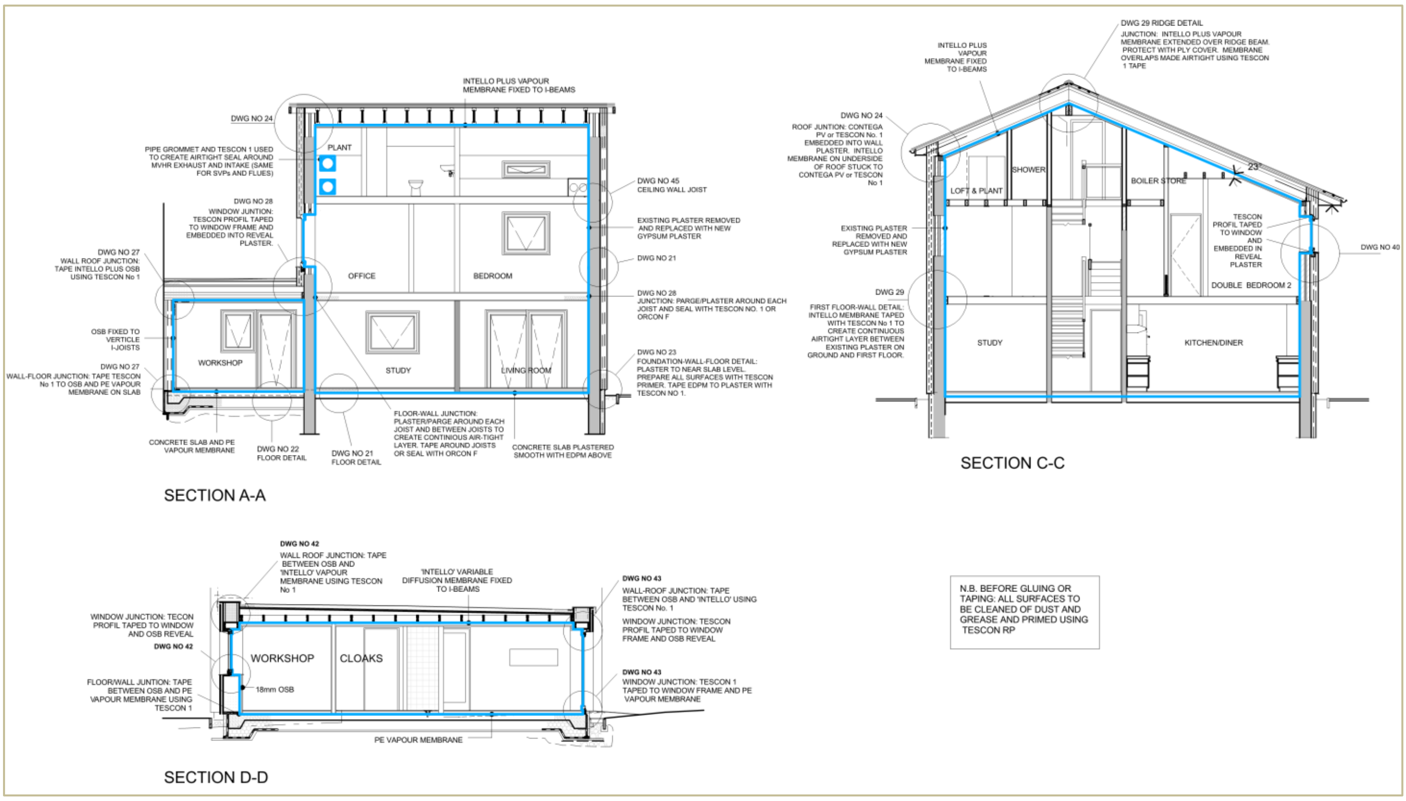
Summary:

	Depressurisation Test	Pressurisation Test	Average	Target:
Airflow @ 50 Pa (m^3/hr):	91.6	89.0	90.3	n/a
Air Change Rate (ACH^{-1} @ 50 Pa):	0.21	0.20	0.20	0.6
Air Permeability ($m^3/hr/m^2$ @ 50 Pa):	0.22	0.21	0.21	n/a
Air flow exponent, n-value:	0.71	0.74	0.72	0.5 < n < 1.0
Correlation coefficient, r^2-value:	0.99	0.99	0.99	r2 > 0.98

Retrofit airtightness details

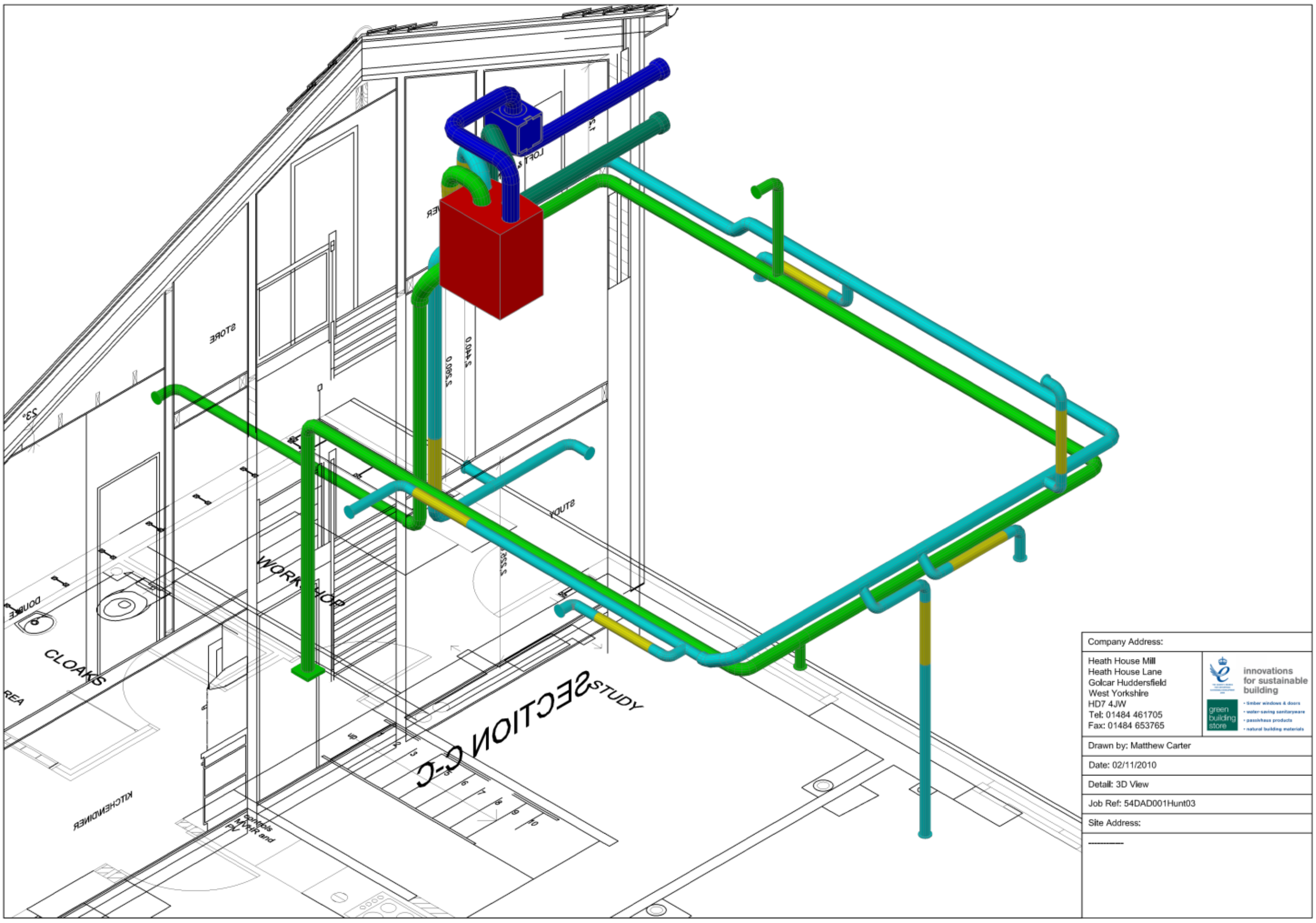
Steel penetration through airtightness layer – welding into web to simplify airtightness detailing.	Pre-parging around existing floor joists. Taped ends encased in plaster.
	
Airtightness sequencing – part of membrane installed as roof was being constructed	Airtightness grommet around soil-vent-pipe
	

5 Section drawings showing airtightness layer (blue lines) references to junction detail drawings are circled



12/13 MVHR – rigid, branch system with a Paul Novus 300, external frost protection unit and duct post-heater

The actual installation varies slightly from the schematic below in that the MVHR unit was located against an external wall with shorter cold duct lengths; the former to reduce the risk of sound transmission through a timber stud wall and the latter to optimise the system efficiency.



Legend

Dark blue – cold intake ducting and frost protector	Dark green – cold exhaust ducting
Light blue/turquoise – supply ducting (to living/bedrooms)	Light green – extract ducting (from kitchen/bathrooms)
Yellow/gold – sound attenuator	Dark red – MVHR unit

A traditional branch ducting system was used (a duct supplies or extracts air to/from more than one room). Smooth-walled rigid ducting was used in diameters starting at 160mm at the MVHR unit, down to 125mm at the room valves. Sound attenuation was used at key points to reduce noise from the MVHR unit and avoid “crosstalk” between rooms sharing a duct. Supply ducts were insulated with 20mm of wool insulation, as the system was designed to be used with a post duct heater. The MVHR unit is non self-balancing and so intake and exhaust flow rates were measured and the MVHR unit adjusted so that they were in balance. Room air flow rates were set at the room valves. The MVHR unit has a wired digital timer/controller with an alert to remind the user to check/change filters. It is located in the central stairwell. All filters used are G4 class. There is a filter before the external frost-protector, and two within the body of the MVHR unit (intake and extract). The frost protector is thermostatically controlled.

The post-heater is based on hot-water (manufacturer VEAB).

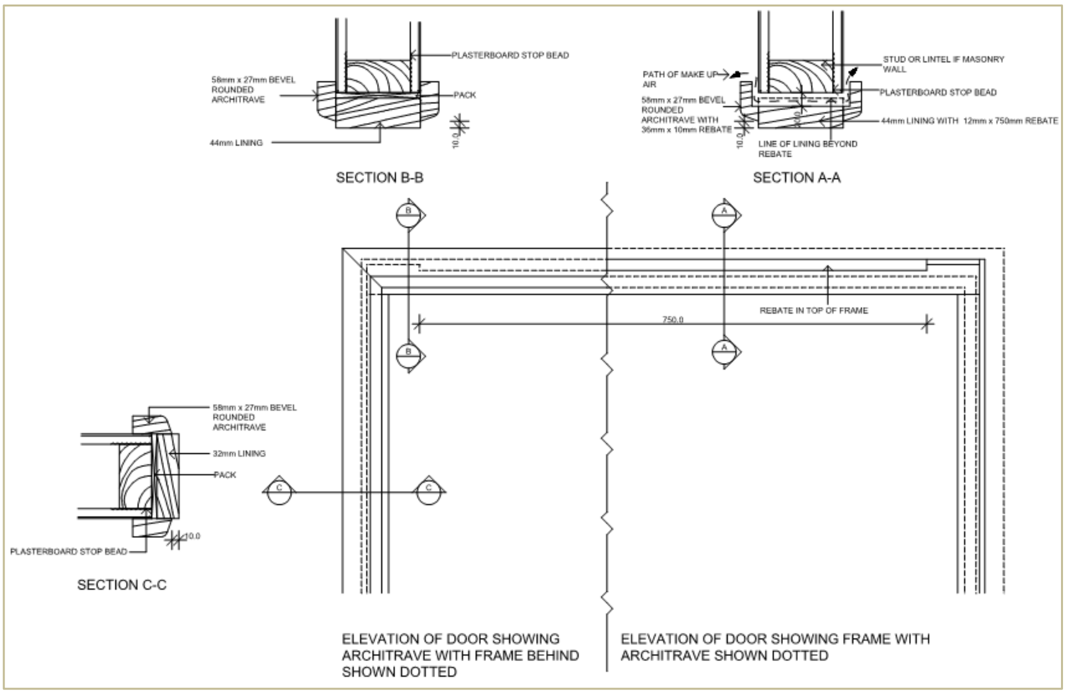
The MVHR unit is a Paul Novus 300 (heat recovery efficiency 93%; specific electrical power 0.24Wh/m^3).

MVHR wall terminals face the prevailing wind on the west facade

MVHR duct post heater – supply ducts following it are insulated

Insulated cold ducts – short lengths, 50mm Armaflex insulation and frost protector

MVHR transit paths within internal door architrave



14 Heating supply

Space heating is via a hot-water post heater. The hot water is supplied by a modulating boiler, which also provides domestic hot water in the winter. Limited direct electric space heating is used in two of the bathrooms and in the main living area. In practice, the occupants have found that the post-heater provides too much heat and the electric heating (normally a few hundred watts) is sufficient to make the building comfortable in the core winter period. West-facing solar thermal panels provide nearly 100% of summer hot water, which is stored in a 500 litre thermal store – manufacturer Rotex. A 3.8kWp photo-voltaic array provides 3200kWh per annum.

20 Building services planning

Space heating, hot water and ventilation planning were provided by Janet Cotterell, Adam Dadeby and Jonathan Williams, with input from appliance suppliers.

15 Certification PHPP – verification worksheet

Passive House Verification

Building:	Totnes Passivhaus	
Location and Climate:	South West England	South West
Street:	Hunters Moon	
Postcode/City:	TQ9 6, Dartington, TOTNES	
Country:	United Kingdom	
Building Type:	Semi-detached	
Home Owner(s) / Client(s):	Adam Dadeby and Erica Aslett	
Street:	as above	
Postcode/City:	as above	
Architect:	Janet Cotterell (Passivhaus Homes)	
Street:	6A Love Lane	
Postcode/City:	HA5 3EF, Harrow	
Mechanical System:	Green Building Store	
Street:	Heath House Mill, Heath House Lane, Golcar	
Postcode/City:	Huddersfield HD7 4JW	

Year of Construction:	2011, refurb				
Number of Dwelling Units:	1		Interior Temperature:	20.0	°C
Enclosed Volume V_e:	646.0	m^3	Internal Heat Gains:	2.1	W/m^2
Number of Occupants:	4.6				

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 162.4 m^2

	Applied:	Monthly method	PH Certificate:	Fulfilled?
Specific Space Heating Demand:	13	kWh/(m²a)	15 kWh/(m²a)	Yes
Heating Load:	9	W/m²	10 W/m²	
Pressurization Test Result:	0.2	h^{-1}	0.6 h^{-1}	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	68	kWh/(m²a)	120 kWh/(m²a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	38	kWh/(m²a)		
Specific Primary Energy Reduction through Solar Electricity:		kWh/(m²a)		
Frequency of Overheating:	4	%	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)	15 kWh/(m²a)	
Cooling Load:	4	W/m²		

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations with PHPP are attached to this application.

Issued on: 19-09-2011

signed: Peter Warm

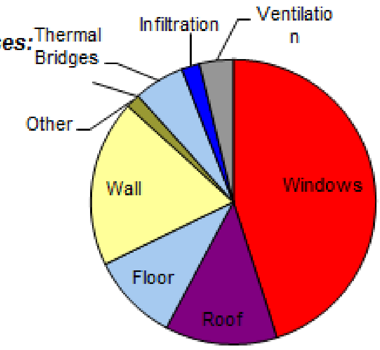
Certification PHPP

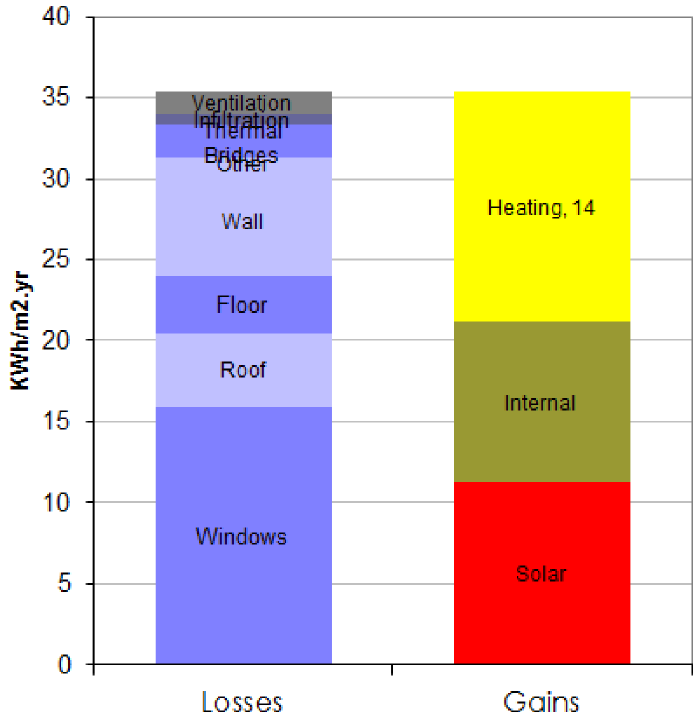
Certifier results

Annual Heat balance kWh/m²

	Losses	Gains
Windows	15.9	
Roof	4.5	
Floor	3.5	
Wall	6.7	
Other	0.6	
	0.0	
Thermal Bri	2.0	
Infiltration	0.7	
Ventilation	1.4	
Solar		11.2
Internal		9.9
Heating		14.2
Totals	***35.4***	***35.4***

Heat losses:





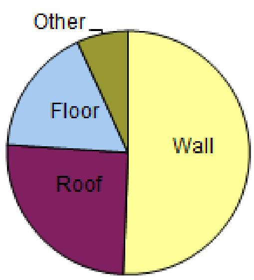
Turn off htg display? ***No***

Window breakdown

	Losses kWh/m²	Heat gains kWh/m²	Balance kWh/m²	area m² (% of wall)
North	3.0	1.2	-1.9	8.9 (3.7%)
East	5.1	3.8	-1.3	13.2 (5.6%)
South	2.8	3.3	0.5	6.8 (2.9%)
West	5.0	3.4	-1.6	12.5 (5.3%)
Horizontal				
Total	15.9	11.7	-4.3	41.3 (17.4%)

Heat loss form factor
(what is it?)

Heat loss form factor	
Wall	1.5
Roof	0.7
Floor	0.5
Other	0.2
Total	***2.88***



Average fabric U value required	0.131 W/m2.yr
Average fabric U value of design	0.122 W/m2.yr

Heat Losses

1	Windows	2,589 kWh/a
2	Exterior Wall - Ambient	1,090 kWh/a
3	Roof/Ceiling - Ambient	731 kWh/a
4	Foor slab/ basement ceil	575 kWh/a
5	Perimeter TB (length/m)	173 kWh/a

16/17 building/construction costs

The construction cost was £2037 per m² of treated floor area (TFA = 162m²) – £330,000 in total.